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Kingston

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(54) **RFID LOCATION SYSTEM AND ASSOCIATED METHODS FOR A PRODUCT DISPENSING SYSTEM**

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F25D 11/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G06Q 10/087*** (2013.01); ***F25D 11/00*** (2013.01); ***F25D 31/002*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. G06Q 10/087; G06Q 20/18; G06Q 30/0185; G06Q 20/203; G06Q 20/3224;
(Continued)

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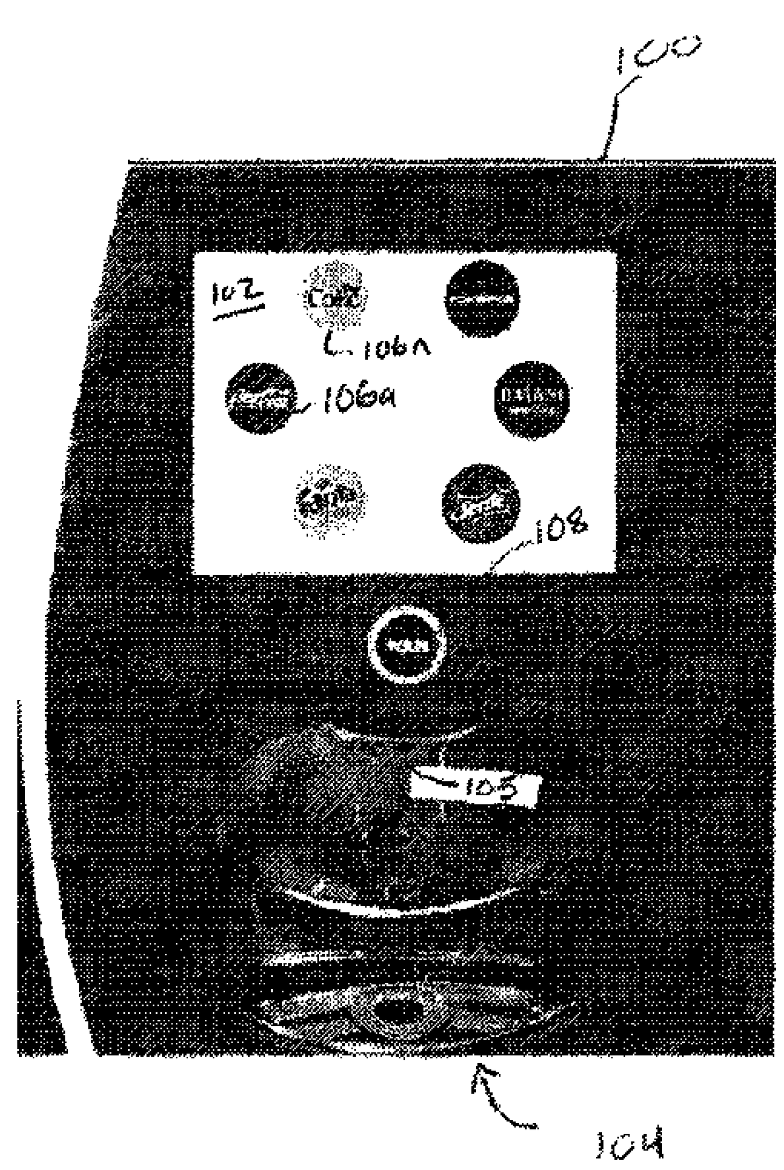
(74) *Attorney, Agent, or Firm* — Meunier Carlin & Curfman LLC

(57) **ABSTRACT**

A machine and process for providing consumer products may include a set of positions configured to contain consumer products or containers in which ingredients are used to form consumer products. The consumer products or containers may include radiofrequency identification (RFID) tags. A set of antennas, where at least one antenna is disposed at each position, may be configured to output and receive RF signals. A transceiver may be in electrical communication with the antennas, and be configured to generate the RF signals. A processor may be in communication with the transceiver, and be programmed to (i) receive RFID signals from the RFID tags at the set of positions, and (ii) identify locations of the RFID tags to determine that corresponding consumer products or containers of ingredients are in correct positions.

18 Claims, 8 Drawing Sheets



(51) **Int. Cl.**

F25D 31/00	(2006.01)
G06K 7/10	(2006.01)
G06K 19/077	(2006.01)
G06Q 20/18	(2012.01)
G06Q 30/00	(2012.01)

(52) **U.S. Cl.**
CPC ***G06K 7/10217*** (2013.01); ***G06K 7/10366*** (2013.01); ***G06K 19/07758*** (2013.01); ***G06Q 20/18*** (2013.01); ***G06Q 30/0185*** (2013.01)

(58) **Field of Classification Search**
CPC ... G06Q 20/3278; F25D 11/00; F25D 31/002; G06K 7/10217; G06K 7/10366; G06K 19/07758; G06K 19/0723; G06K 7/10009; G06K 7/10356; G07G 1/009
USPC 705/28
See application file for complete search history.

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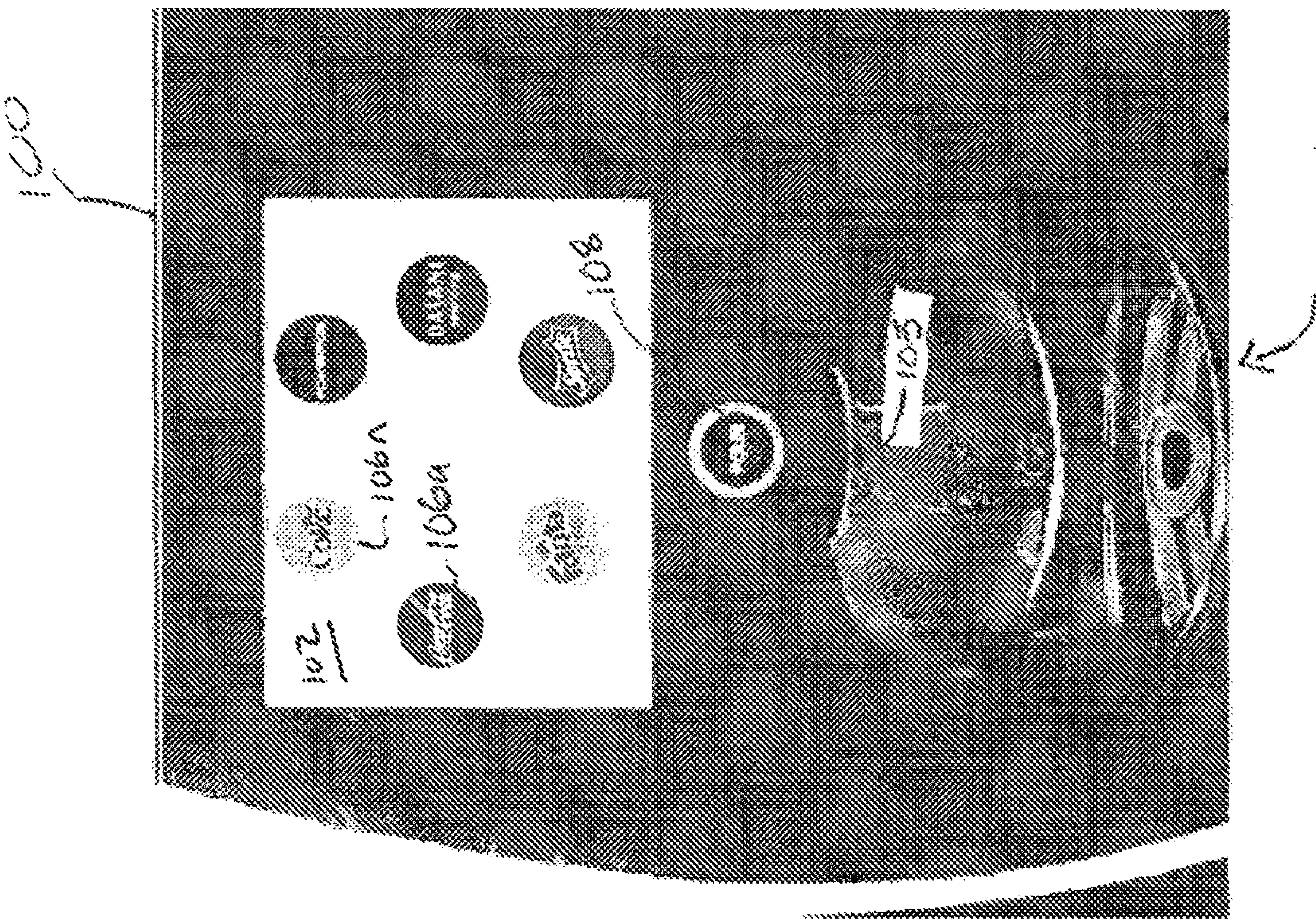

FIG. 1

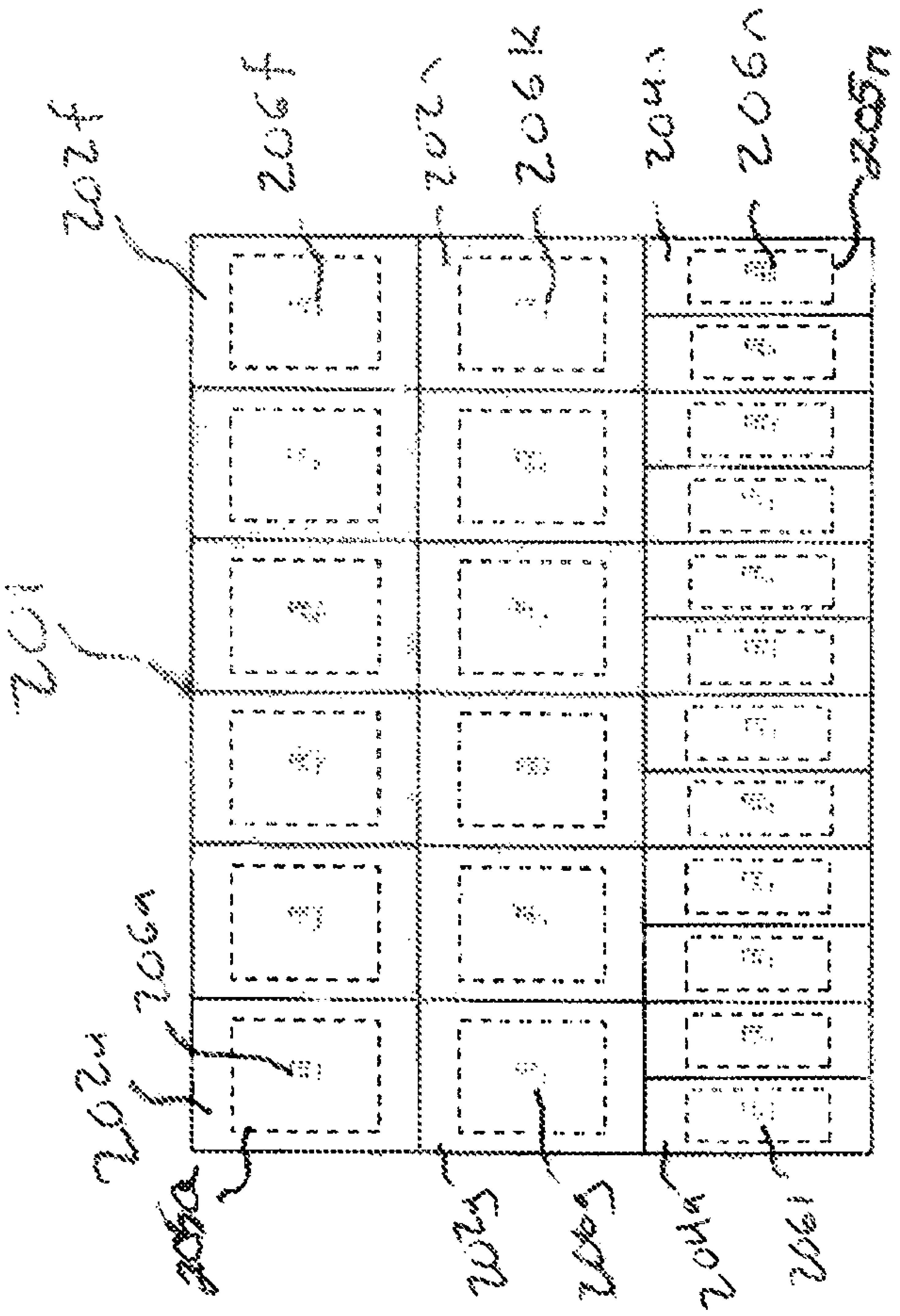

FIG. 2B

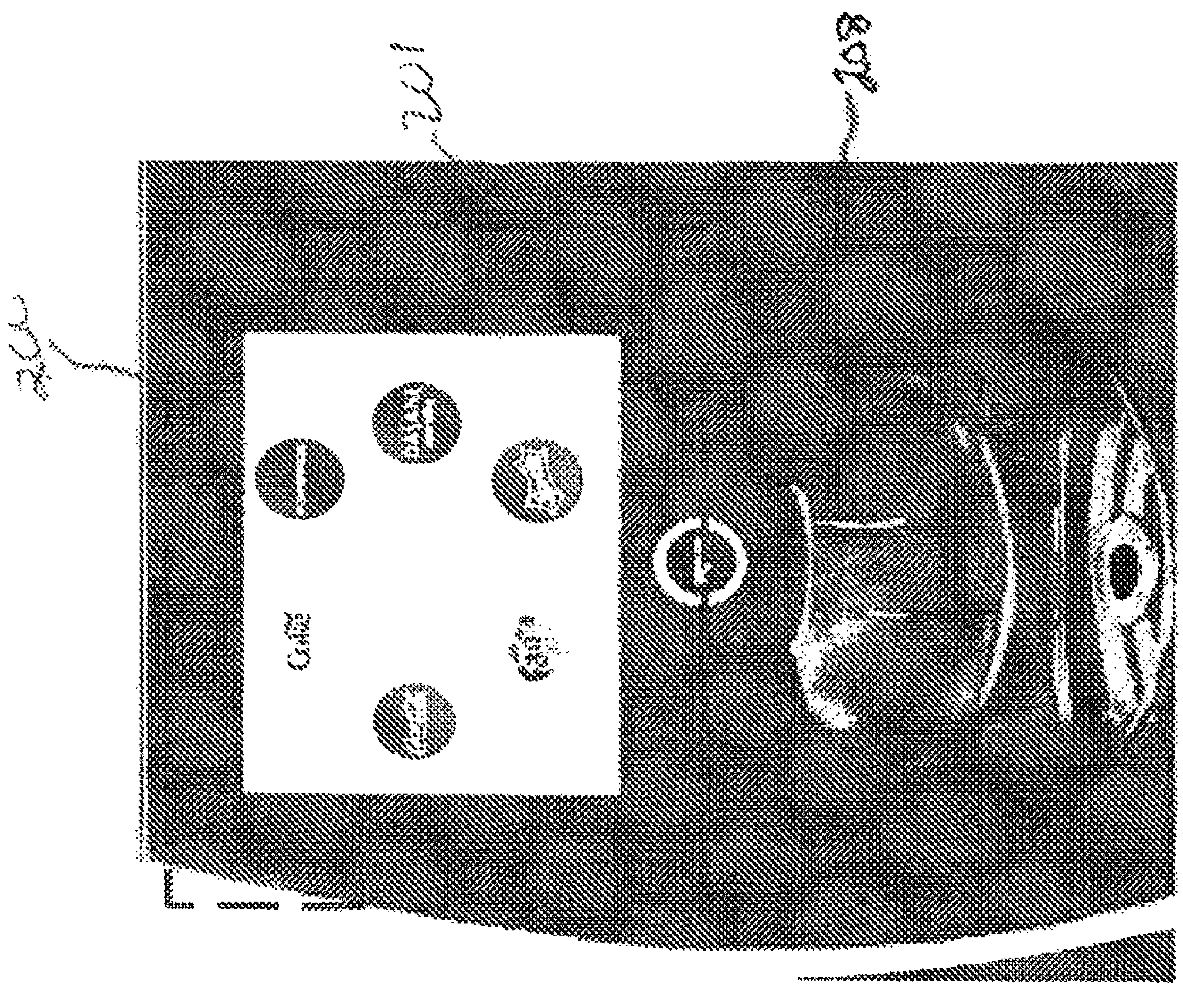

FIG. 2A

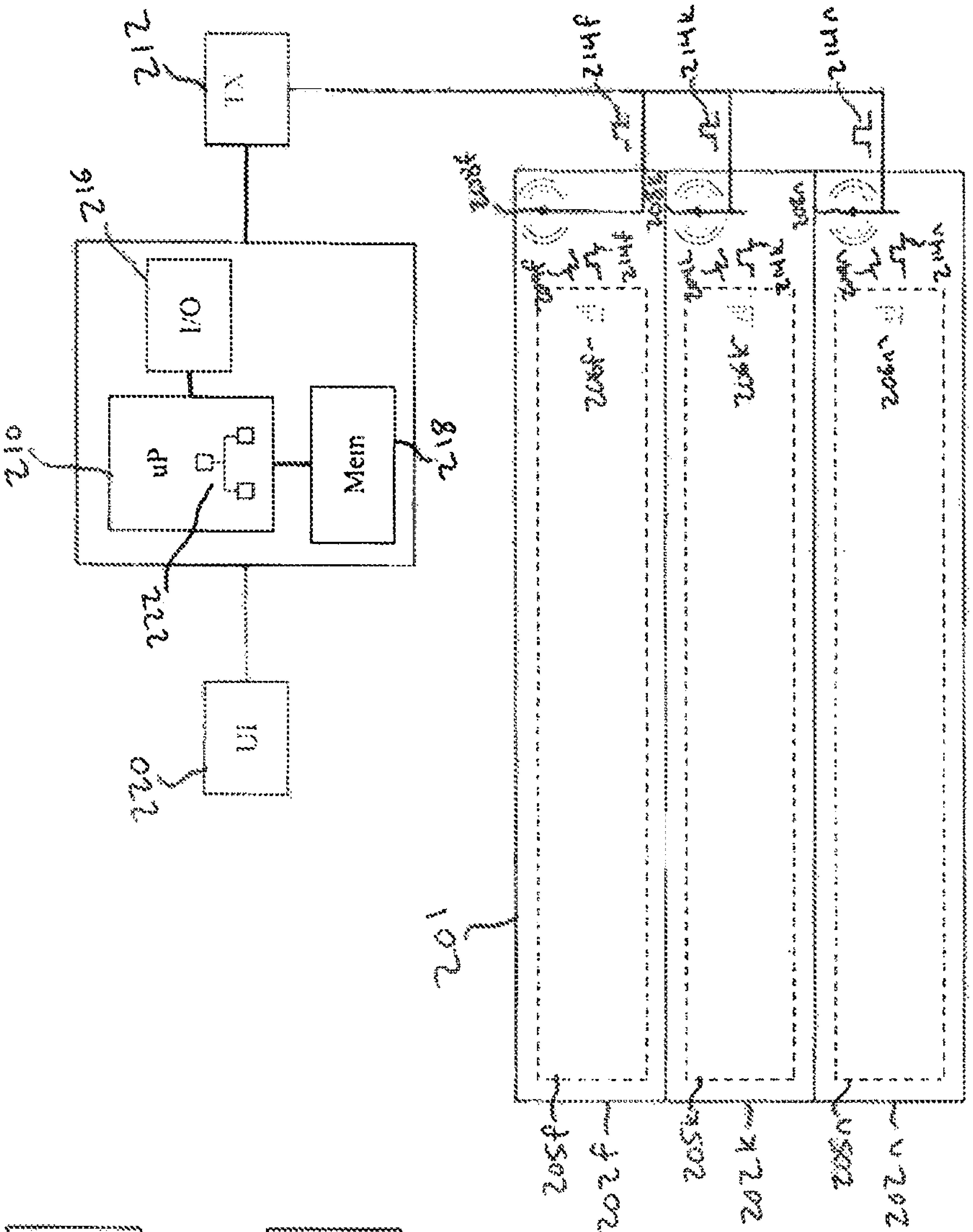
212
TX
216
I/O
210
uP
Mem
218
222
UI
220
201

FIG. 2C

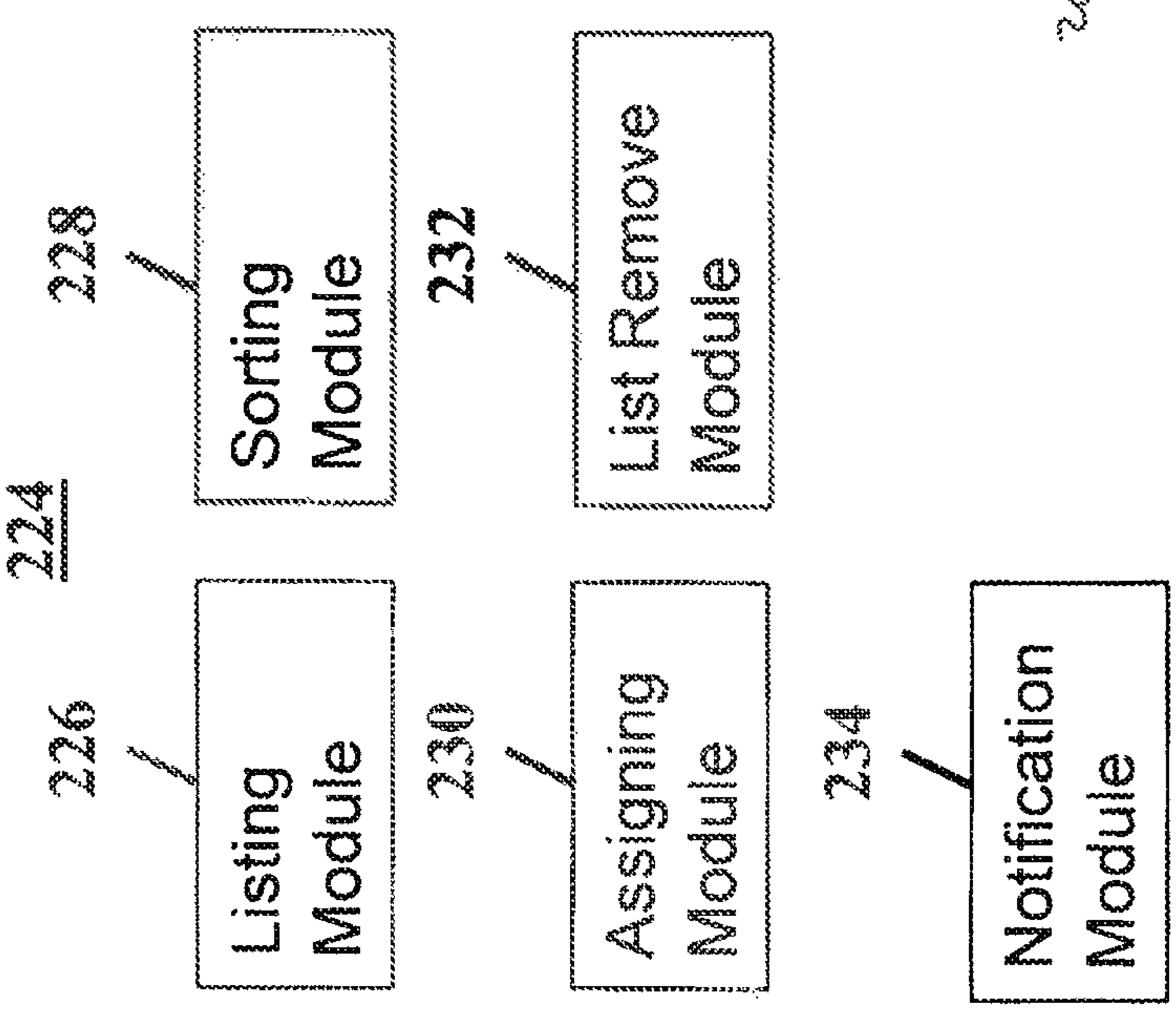
224
226
Listing Module
228
Sorting Module
230
Assigning Module
232
List Remove Module
234
Notification Module

FIG. 2D

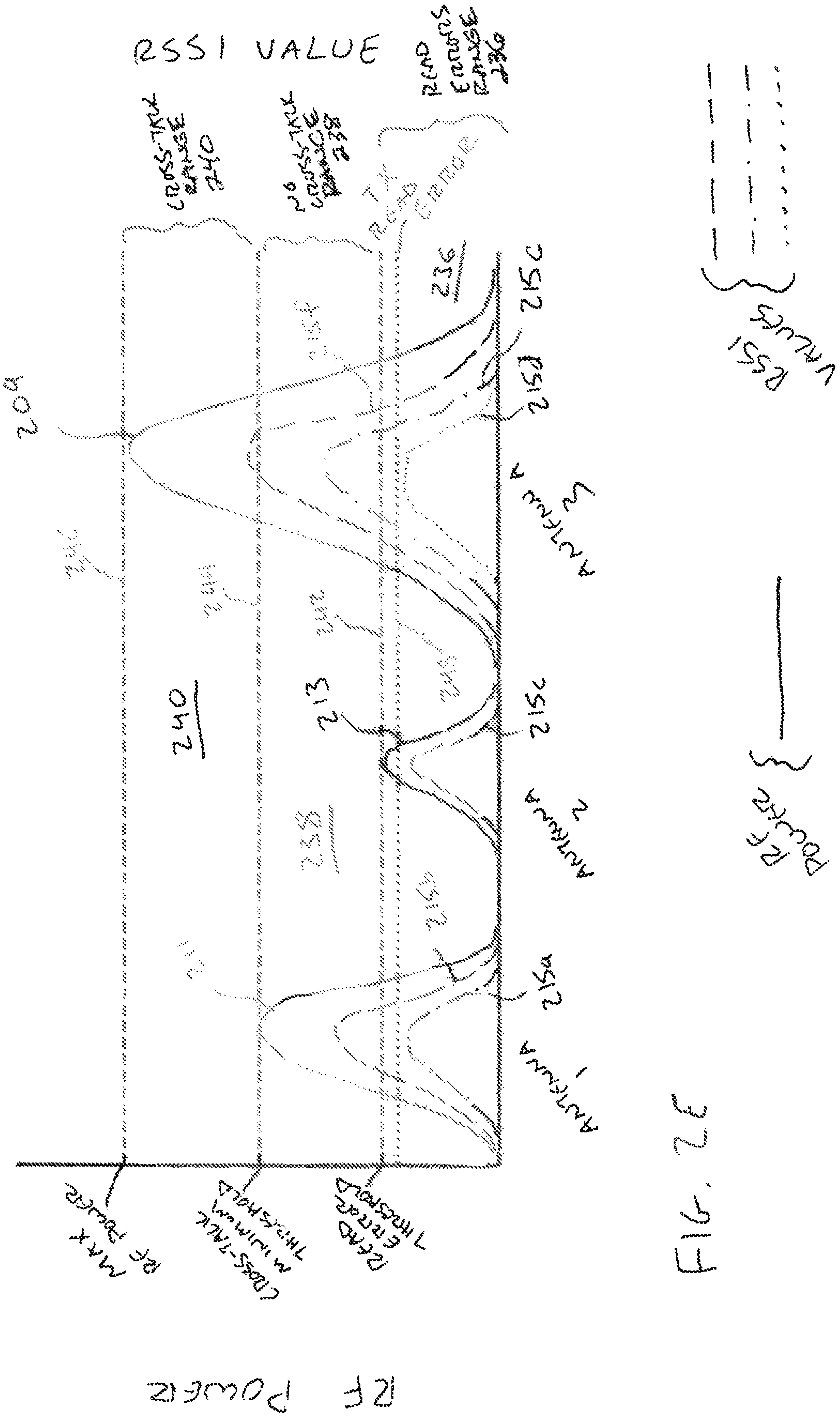
RSSI VALUE
CROSS-TALK RANGE 240
2° CROSS-TALK RANGE 238
TX READ ERROR
READ ERRORS RANGE 236
RSSI VALUES
RF POWER
209
236
215c
215d
215b
215f
244
242
246
240
213
238
211
215a
ANTENNA 1
ANTENNA 2
ANTENNA 3
MAX RF POWER
CROSS-TALK MINIMUM THRESHOLD
READ ERROR THRESHOLD
RF POWER

FIG. 2E

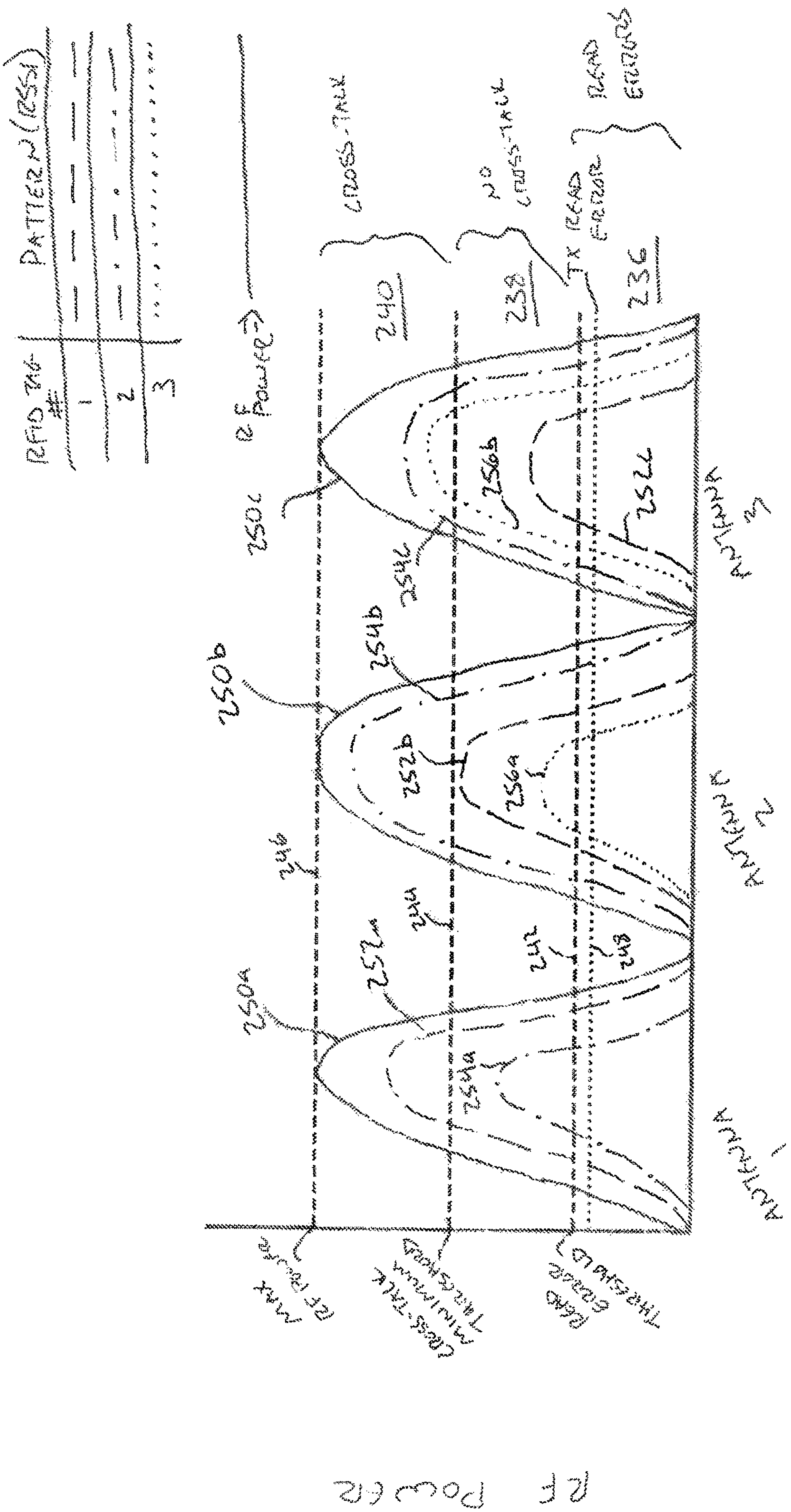
RFID TAG #
PATTERN (RSSI)
1
2
3
RF POWER →
CROSS-TALK
NO CROSS-TALK
TX READ ERROR
READ ERRORS
240
238
236
250a
250b
250c
252a
252b
252c
254a
254b
254c
256a
256b
242
244
246
248
ANTENNA 1
ANTENNA 2
ANTENNA 3
MAX RF POWER
CROSS-TALK MINIMUM THRESHOLD
READ ERROR THRESHOLD
RF POWER

FIG. 2F

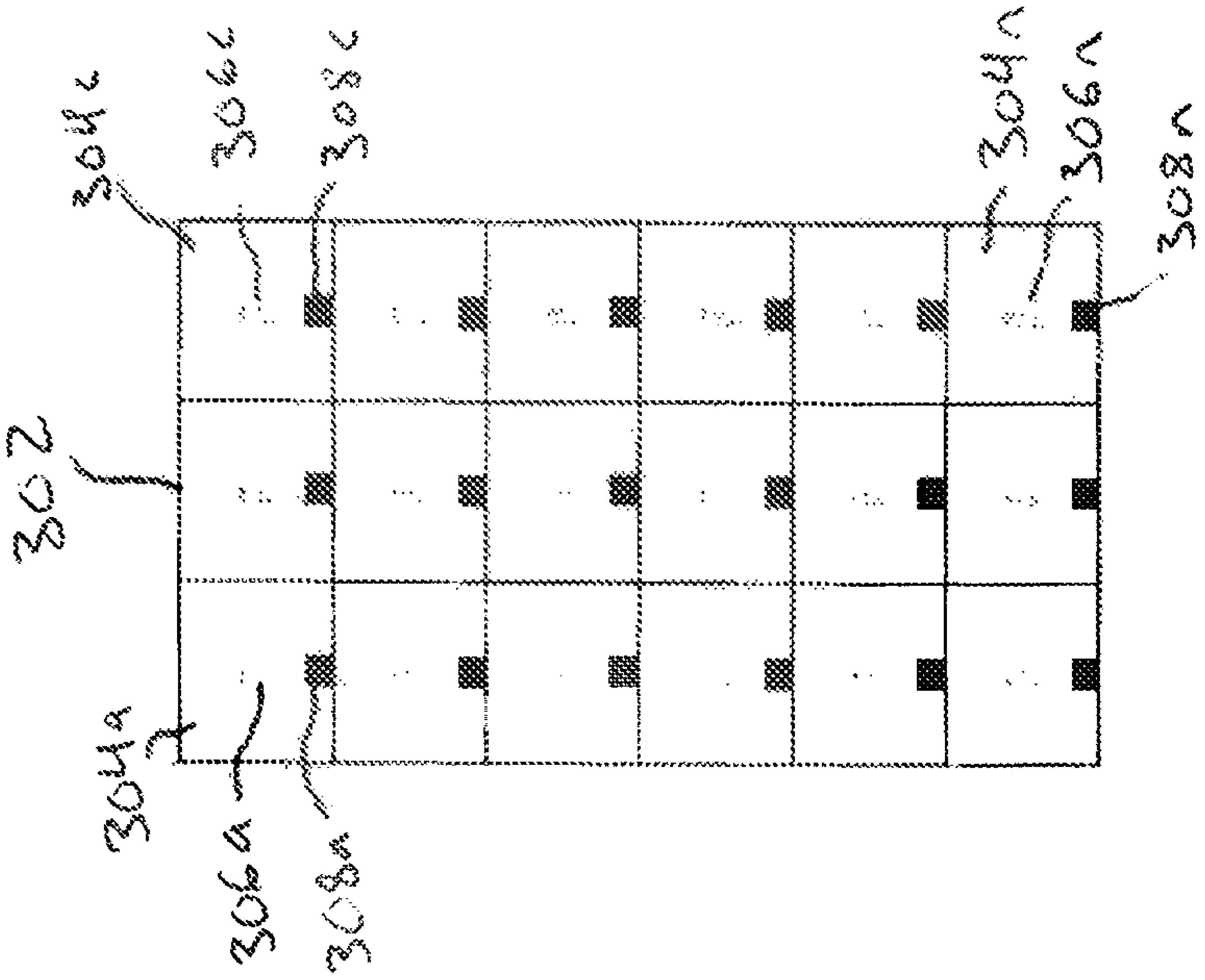

FIG. 3B

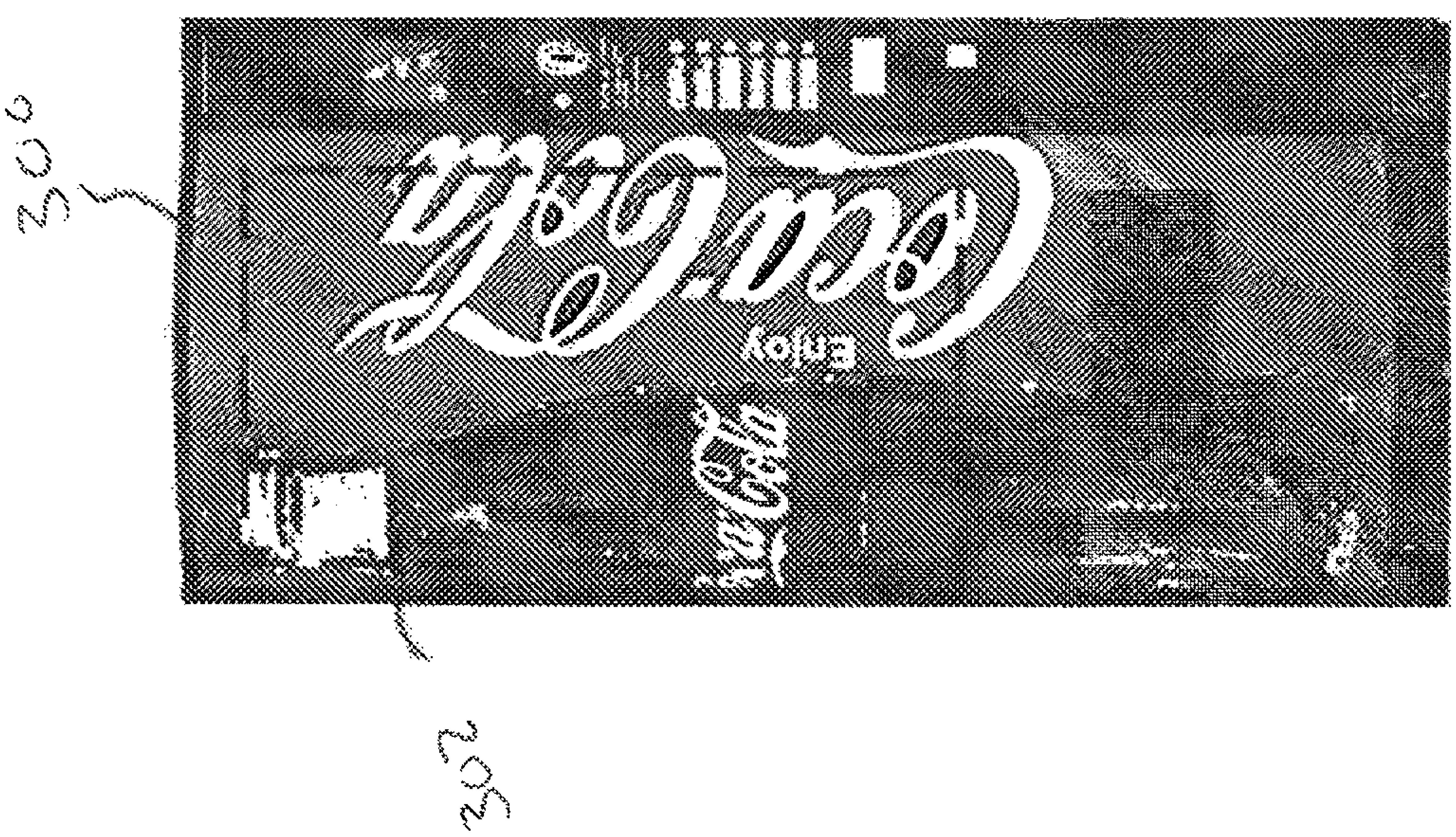

FIG. 3A

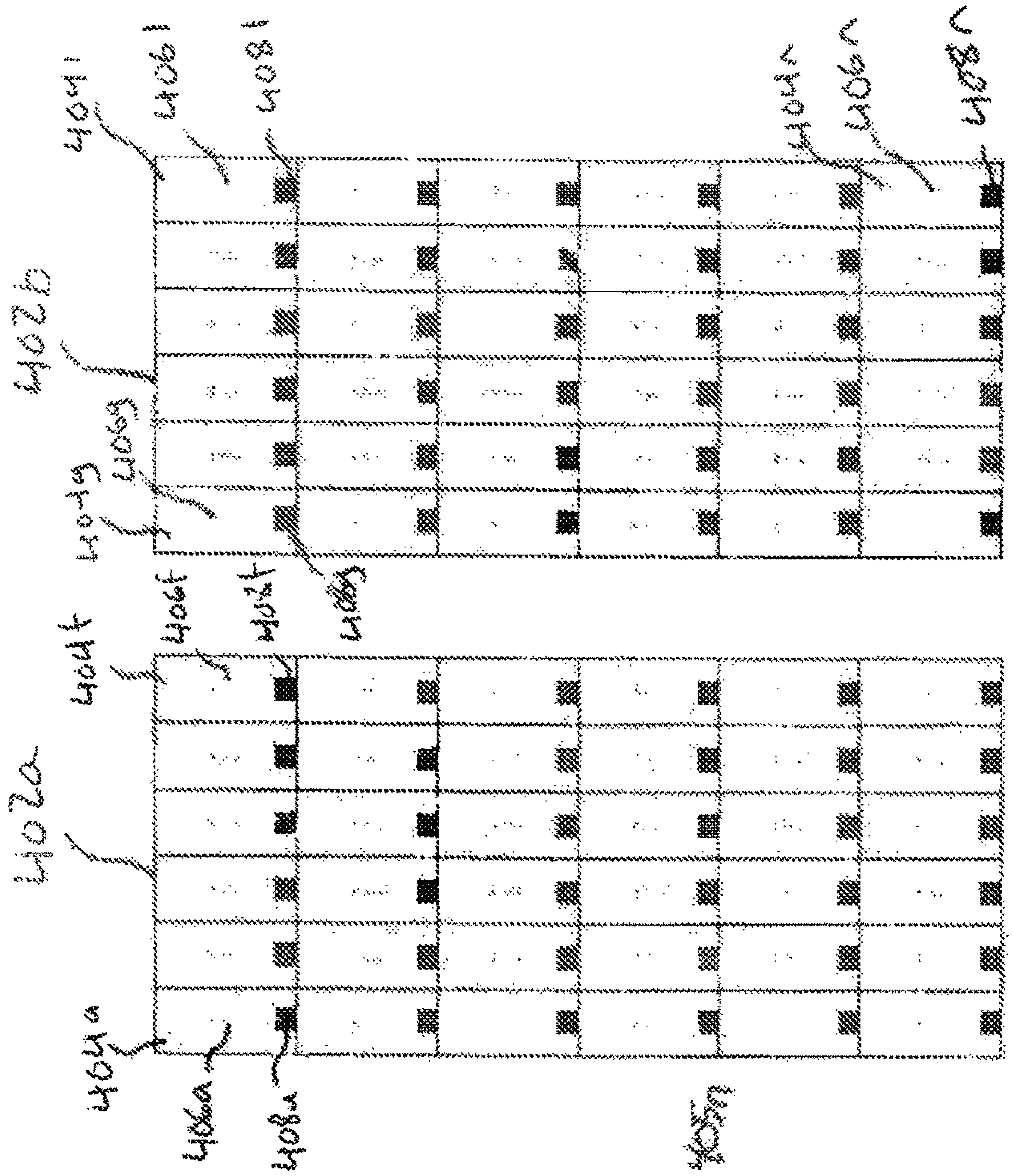

FIG. 4B

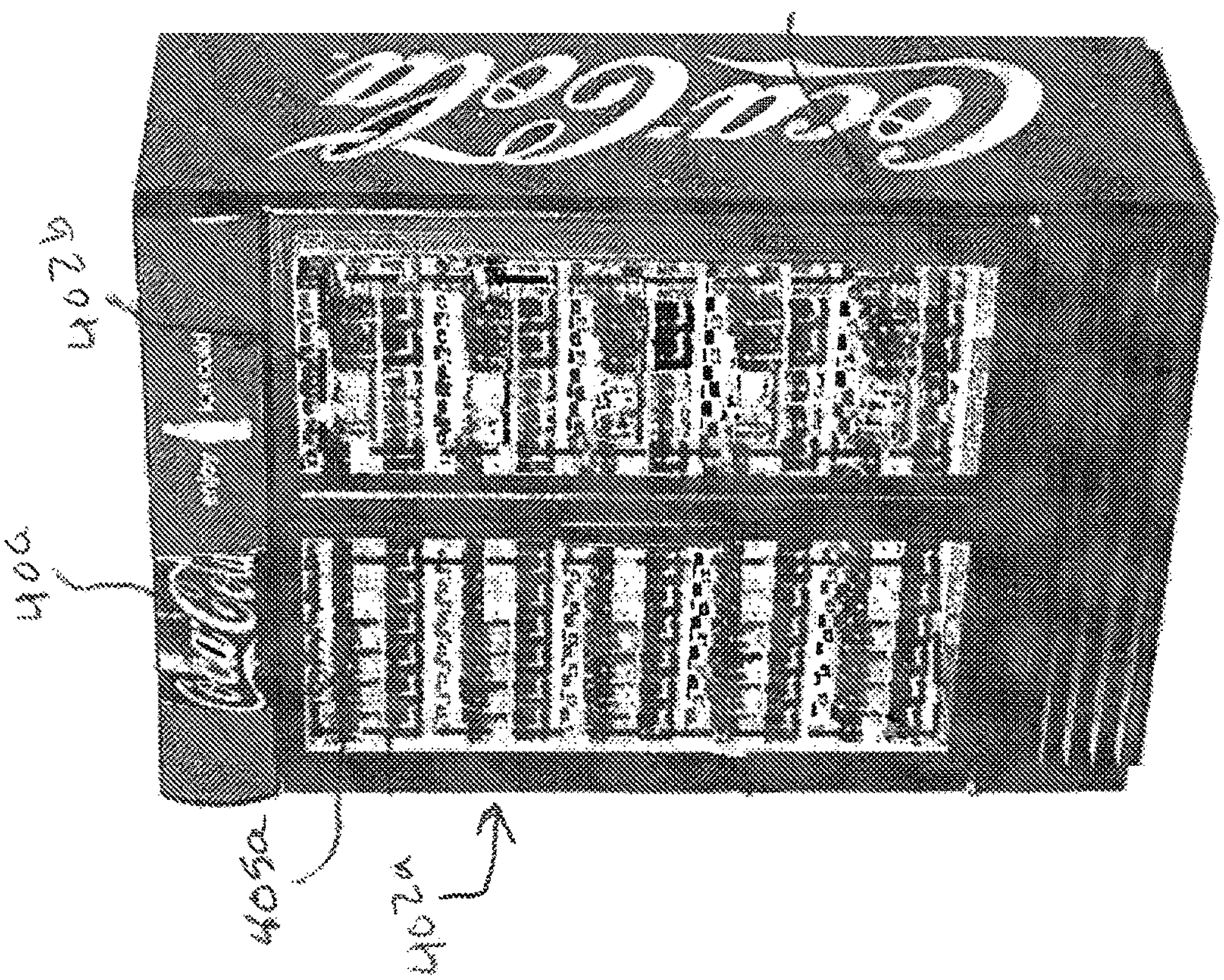

FIG. 4A

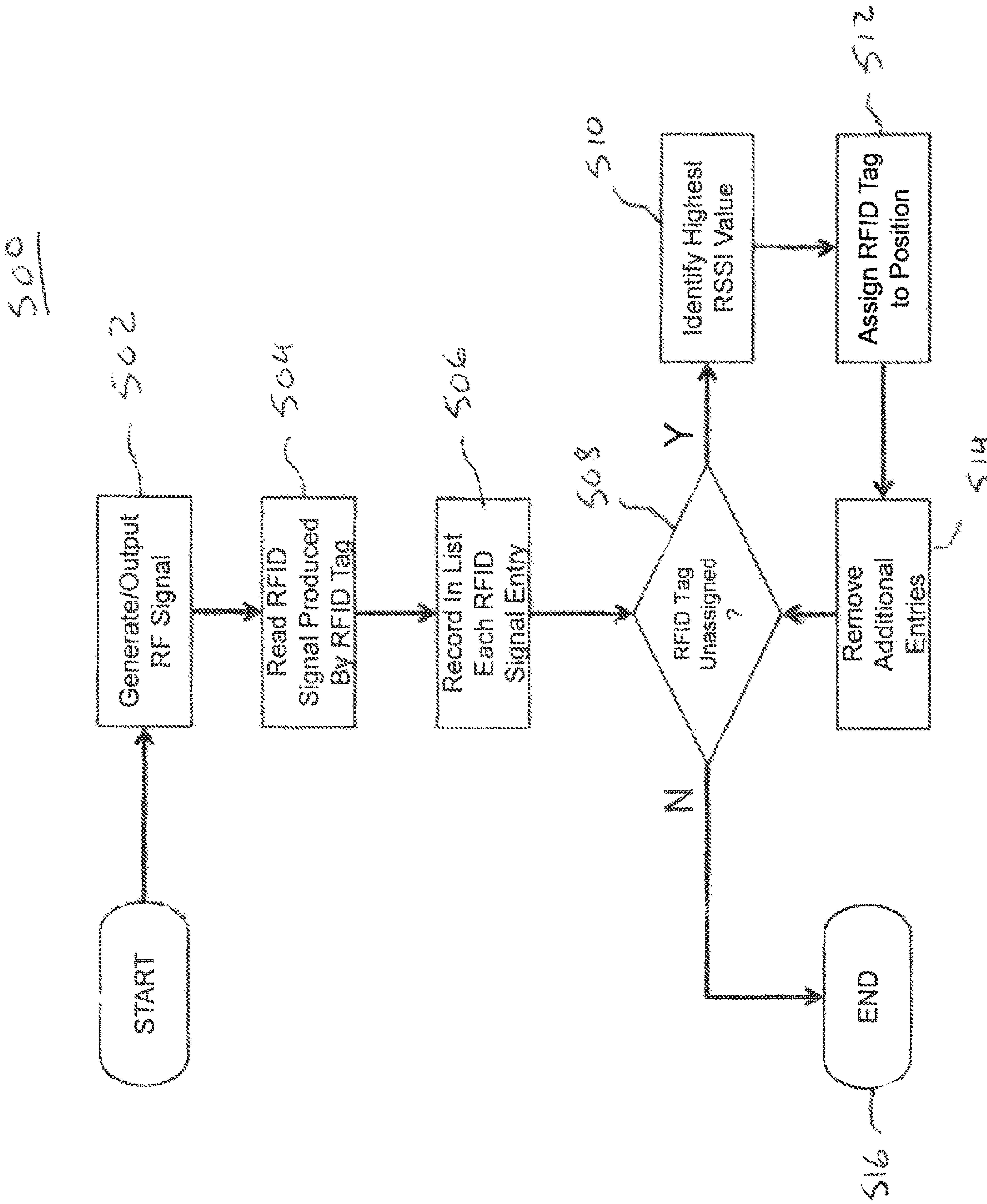
500
START
Generate/Output RF Signal
502
Read RFID Signal Produced By RFID Tag
504
Record In List Each RFID Signal Entry
506
RFID Tag Unassigned ?
508
Y
N
Identify Highest RSSI Value
510
Assign RFID Tag to Position
512
Remove Additional Entries
514
END
516

FIG. 5

RFID LOCATION SYSTEM AND ASSOCIATED METHODS FOR A PRODUCT DISPENSING SYSTEM

RELATED APPLICATIONS

This application is a national stage application filed under 35 U.S.C. § 371 of PCT/US2018/042309 on Jul. 16, 2018, which claims priority to U.S. provisional patent application Ser. No. 62/534,104 filed on Jul. 18, 2017, the contents of which are hereby incorporated by reference in their entireties.

FIELD OF THE INVENTION

The present invention relates to a beverage dispenser and, more specifically, to locating positions of ingredient packages or containers and/or other product packaging in beverage dispensers using radio frequency identification (RFID) tags.

BACKGROUND OF THE INVENTION

Beverage and other product dispensers are used in a variety of venues. As understood in the art, beverage dispensers often include ingredients that enable users to dispense desired beverages. Some dispensers enable combinations of ingredients and/or flavors to allow consumers the ability to create desired custom beverages. In addition to providing a more specific beverage that a user prefers, these dispensers may be used for marketing and attracting consumers to venues that house the dispensers.

Technology for beverage dispensers and other dispensers or machines is also improving. For example, the ability to customize a beverage has been developed over the years by providing selectable ingredients and flavors for consumers to select in purchasing a beverage. As demand for customized beverages continues to rise, logistical concerns, such as servicing the dispensers and replacing ingredients and flavors, increase. Different ingredients and flavors may find different levels of demand in different venues. Unpredictable patterns for how long an ingredient or flavor will last before becoming empty provide useful feedback to the operators and/or servicers of the dispensers. However, the patterns present unique difficulties with servicing.

An operator of a beverage dispenser may track varying timelines for each ingredient and/or flavor so that each ingredient and flavor may be timely replaced to avoid an ingredient or flavor becoming empty. However, what typically occurs now is that the machine registers an empty status, and the operator replaces the ingredient or beverage.

In replacing the ingredients and/or flavor in packages or containers, the operator typically identifies which ingredient(s) and/or flavor(s) are to be replaced, and then removes the empty packaging and places or inserts a new, full ingredient and/or flavor in the respective position(s) in the dispenser. Operator error in replacing the ingredients and/or flavors (or beverages in the case of vending machines or coolers), however, can and does occur when the operator incorrectly locates and replaces one ingredient or flavor with another. For example, an operator may accidentally replace a cherry flavoring container in a grape flavoring container position. Such a mistake can contaminate lines of the dispenser, which then requires an operator to clean and possibly decontaminate the lines.

Current dispensers may utilize radiofrequency identification (RFID) systems to identify packaging of ingredients

and/or flavors, full or empty, as the packaging is inserted or removed from locations of the dispenser. The packaging may have an RFID label adhered thereto, and may be programmed with information including ingredient type, remaining volume, expiration date, and other useful data.

Existing dispensers may utilize an RFID reader in conjunction with antennas to read the ingredient package's tag data. In order to know locations of the particular ingredients and/or flavors, an array of antennas are used to sense individual tag positions. However, to avoid cross-reading or incorrect location identification of the ingredient and/or flavoring packaging, a minimal amount of RF power is used to avoid cross-reading of the RFID chips on packages or containers in neighboring locations from one being read. Additional factors, such as RFID tag sensitivity, antenna gain variances, physical separation variation between RFID tags and antennas, sensitivity as a function of frequency of operation, and other factors create difficulties and unreliability in the reading the RFID tags. Hence, as a result of reading errors, dispenser owners or operators have been reluctant to use or rely on such RFID reading technology, and, thus, continue to have faults that existed without the use of RFID systems.

BRIEF SUMMARY OF THE INVENTION

Dispenser machines or dispensers ("machines") that provide consumer products, such as consumable products (e.g., beverages, foods), to consumers may be configured to identify positions of product ingredients and/or flavors in packaging or containers, products, or other dispensable items by reading RFID tags attached thereto. In identifying the ingredients and/or flavors, or products themselves, in allocated positions, such as slots or bins, a certain power level (e.g., maximum power level) of an RF signal may be directed to locations in which packaging or products to read the RFID tags attached thereto. By applying the certain RF power levels, such as a maximum power level RF signal or at least a power level that causes cross-reading, to the RFID tags along with a sorting process, a read success rate for reading the RFID tags may be improved over conventional techniques that generally include minimum RF power levels to avoid cross-reads. The RFID tags may return RFID signals having an RSSI value in response to the RF signal that is read by the machine. The machine may sort position records of product ingredients and/or flavors or products themselves based on the RSSI values.

One embodiment of a process for identifying positions of containers or products in a machine may include generating an RF signal at a certain power level. The RF signal may be output to each position of a set of positions in which the containers are positioned. RFID signals produced by the RFID tags in response to being energized by the RF signal may be read and recorded into a list including entries for each read RFID signal and sorted on a location-by-location basis. Correct positions of each RFID tag may thereby be determined.

Another embodiment of a method for identifying positions in which of radiofrequency identification (RFID) tags affixed to consumer products or containers in which ingredients used to form consumer products by a machine that provides consumer products to consumers are located may include generating a radiofrequency (RF) signal at a certain power level. The power level may be a maximum power level in an embodiment. The RF signal may be output to each position of a set of positions at which the consumer products or containers are positioned. RFID signals produced by the RFID tags may be read in response to being energized by the RF signal, where the RFID signals of different tags including (i) a unique product identifier and (ii) a unique RFID tag identifier. The RFID signals may also include data representative of a product identifier. The RFID signals have a signal strength that enables measurement of received signal strength indicator (RSSI) values. Entries may be recorded into a list for each read RFID signal. The entries may include (i) a corresponding unique RFID tag identifier, (ii) a corresponding position identifier, and (iii) a corresponding measured RSSI value. The entries may optionally include a product identifier. A determination as to correct positions of each RFID tag may be made by (i) identifying a highest RSSI value in the list, (ii) assigning the corresponding RFID tag identifier to a position based on the corresponding position identifier, (iii) removing, from the list, additional entries including the corresponding RFID tag identifier, and (iv) repeating identifying, assigning, and removing until each of the RFID tags are assigned to a position.

One embodiment of a machine for providing consumer products may include a set of positions configured to contain consumer products or containers in which ingredients are used to form consumer products. The consumer products or containers may include radiofrequency identification (RFID) tags. A set of antennas, where at least one antenna is disposed at each position, may be configured to output and receive RF signals. A transceiver may be in electrical communication with the antennas, and be configured to generate the RF signals. A processor may be in communication with the transceiver, and be programmed to (i) receive RFID signals from the RFID tags at the set of positions, and (ii) identify locations of the RFID tags to determine that corresponding consumer products or containers of ingredients are in correct positions.

BRIEF DESCRIPTION OF THE DRAWINGS

Illustrative embodiments of the present invention are described in detail below with reference to the attached drawing figures, which are incorporated by reference herein and wherein:

FIG. **1** is an illustration of an illustrative machine that dispenses consumer products, such as beverages;

FIGS. **2**A-**2**F are illustrations of an illustrative machine inclusive of a set of positions along with operational signaling used to dispense consumer products and verify correct positioning thereof;

FIGS. **3**A and **3**B are illustrations of an illustrative vending machine inclusive of a set of positions and RFID sensors used to dispense consumer products;

FIGS. **4**A and **4**B are illustrations of an illustrative cooler inclusive of a set of positions and RFID sensors that contain consumer products for access by users; and

FIG. **5** is an illustration of an illustrative flow diagram of a process executable by a machine that identifies positions of radiofrequency identification tags, such as positions in the machine, associated with ingredient containers or products.

DETAILED DESCRIPTION OF THE INVENTION

With regard to FIG. **1**, an illustration of an illustrative machine **100** that dispenses consumer products, such as beverages, to consumers is shown. The machine **100** may be a dispenser, but may alternatively be a cooler, vending machine, or any other machine configured to provide consumer products for consumers to purchase or otherwise obtain, as further described herein. In an embodiment, the beverages may be soft-drinks, fruit beverages, still beverages, water, hot beverages (e.g., coffee), and so on. The machine **100** may be placed in a venue, such as, but not limited to, retail stores, grocery stores, restaurants, malls, sports venues, airports, walkways, or any other public or private location at which a consumer may purchase a consumer product, such as a beverage, from the machine **100**.

The machine **100** may include a user interface **102**, a cavity or other region **104** in which a beverage may be dispensed via a nozzle **105**, icons **106***a*-**106***n* (collectively **106**) indicating brand and/or flavor options to a user, and a button **108** for a user to press to control dispensing of the beverage. It should be understood that the machine **100** is illustrative and that a wide range of alternate configurations may be utilized.

With regard to FIGS. **2**A-**2**C, illustrations of a machine **200** inclusive of a set of positions **201** used to dispense consumer products are shown. The set of positions **200***a* may be slots or other defined locations internal to the machine **200**. For dispensers, the locations typically have tubing that enables fluid to be drawn from containers and dispensed from nozzles. FIG. **2**B is an illustration that shows the set of positions **201** and includes a first set of positions **202***a*-**202***n* (collectively **202**) and a second set of positions **204***a*-**204***n* (collectively **204**). In one embodiment, the set of positions **201** may include three rows of twelve positions, where the first two rows are the first set of positions **202** and the third row is the second set of positions of **204**. It should be understood that alternative configurations of the positions **201** may be utilized.

In one embodiment, the first set of positions **202** may be configured to contain a first set of ingredients, such as macro-ingredients. In one embodiment, the second set of positions **204** may be configured to contain a second set of ingredients, such as micro-ingredients. Macro-ingredients and micro-ingredients may be housed in containers **205***a*-**205***n* (collectively **205**) (shown dashed in FIGS. **2**B-**2**C) such as, but not limited to, pouches, bags, and/or boxes. The containers **205** may include radiofrequency identification (RFID) tags **206***a*-**206***n* (collectively **206**) attached thereto. The RFID tags **206** may be active or passive tags. It should be understood that alternative types of tags or technologies that provide for equivalent functionality of identification may alternatively be utilized.

There are a few types of beverage ingredients, including micro-ingredients, macro-ingredients, and a middle level of ingredients. Micro ingredients are generally acids and flavors that are highly concentrated and are able to produce a beverage using a high ratio (e.g., 150:1) of water or other beverage ingredient to the micro ingredient. Macro ingredients also include acids and flavors that are less concentrated and are used at a lower ratio (e.g., 5:1) of water or other beverage ingredient to the macro ingredient. Other mid-level ingredients may be used in concentration ratios (e.g., 50:1) that are between the micro- and macro-ingredients.

Because the micro-ingredients can be used in such high ratio concentrations, the micro-ingredients may be stored in containers, such as half-liter pouches, and still provide for a sufficient number beverage dispenses in a typical food outlet, such as a restaurant, of an operator of the dispenser **200**. Macro-ingredients are stored in containers that are much larger, such as 2.5, 3, or 5 gallon bags. As a result, in one embodiment, the first set of positions **202** may be configured to be larger than the second set of positions **204**. In other embodiments, the first set of positions **202** and second set of positions **204** may be substantially the same size. Still yet, other configurations of the dispenser **200** may position the sets of positions **202** and **204** outside of the dispenser **200**, such as in a separate cabinet or even in a separate room, and receive the fluids via lines that extend through a cabinet or wall, for example.

In operation, an operator may open and/or remove a front panel **208** of the machine **200** to access the set of positions **201**. The operator may further install, maintain, or replace the macro-ingredients and/or micro-ingredients.

With regard to FIG. **2**C, a right side elevation view of the set of positions **201** is shown. Position **202***f*, position **202***n*, and position **204***n* are positions depicted on a right side of the set of positions **201** of FIG. **2**B. RFID tags **206***f*, **206***k*, and **206***n* are shown to be respectively configured on the containers **205***f*, **205***k*, and **205***n*. In one embodiment, the operator may insert or install the containers **205***f*, **205***k*, and **205***n* inclusive of the ingredients and/or flavors so that the RFID tags **206***f*, **206***k*, and **206***n* are configured to be in a rear portion of the set of positions **200***b*. Other positioning of the RFID tags **206***f*, **206***k*, and **206***n* may be used, as well.

The set of positions **201** may have antennas **208***a*-**208***n* (collectively **208**) disposed to direct or communicate RF signals into respective positions **202** and **204**. Antennas **208***f*, **208***k*, and **208***n* are shown to be configured to be longitudinally aligned with a rear portion of the set of positions **201**. However, other alignments of the antennas **208** are functionally possible, as well. The antennas **208**, in response to receiving RF signals **209***f*, **209***k*, and **209***n*, may communicate data **214***a*-**214***n* (collectively **214**) to a transceiver **212** for processing, as further described hereinbelow.

A processing unit **210** may be in electrical communication with the transceiver **212**. The processing unit **210** may be in communication with an input output (I/O) unit **216** and memory **218**. The I/O unit **216** may be configured to communicate with the transceiver **212** and with a user interface **220** that enables a user to select and pour beverages, as previously described. The processing unit **210** and user interface **222** may also enable an operator to receive messages, such as error messages, notifications, and alerts during servicing, as further described herein.

The processing unit **210** may be implemented using one or more processors, one or more cores (e.g., a multi-core processor), or may be part of one or more application specific integrated circuits (ASICs) and/or digital signal processors (DSPs). Alternatively, the processing unit **210** may be formed of analog or other circuitry. The processing unit **210** may be configured to implement any of the processes described herein, and may be implemented using hardware, software, firmware, or combinations thereof. The processing unit **210** may be configured to execute software **222** that perform certain functions, as further described herein.

With regard to FIG. **2**D, a block diagram inclusive of illustrative software modules **224** that may form part of the software **222** of FIG. **2**C to enable sorting of values in a list representative of RFID tags in positions is shown. The modules **224** may include a listing module **226** for adding values to a list and a sorting module **228** for sorting values in the list. An assigning module **230** may include assigning RFID tags to respective positions **202** and **204**. In assigning RFID tags, and consequently packaging or products, to respective positions **202**, one embodiment may include identifying a highest RSSI value in association with a position from amongst common RFID tag IDs and assigning the corresponding RFID tag and associated data to the position. Additionally, a list remove module **232** may include removing additional entries from the list corresponding to the RFID tag most recently assigned to a position, thereby eliminating potential for misassignments and improving computing and memory efficiency. In some embodiments, the modules **224** may include a notification module **234** that supports a user interface, such as a touch-screen, keypads, buttons, or any other user interface elements, configured to provide notifications in the condition of any error or feedback milestone. For example, the notification module **234** may provide notifications in response to, but not limited to, an RFID tag placed in an incorrect position. One of ordinary skill in the art will appreciate that notifications may correspond to a variety of events including, but not limited to, warning a user of an error and providing diagnostic information, as well as others. An example of the modules **224** in operation is provided in further detail hereinbelow.

One embodiment of a method of operation may include reading the RFID tags **206** with the antennas **208**. When RF power is applied by the RF signals **209** to the RFID tags **206**, the RFID tags **206** may return a response signal having a signal strength that can be measured as a receive signal strength indicator (RSSI) value by the transceiver **212** and/or processing unit **210**. The RSSI value is a measure of signal strength of the RFID tag's **206** response signal. The processing unit **210** may utilize the RSSI values as indicators as to which RFID tags **206** are closest to respective antennas **208**. However, RSSI values may be received from multiple RFID tags, such as RFID tags **206***f* and **206***k*, to a single antenna **208***f* due to multiple RFID tags being activated by an RF signal, such as RF signal **209***f*, for example.

As an example, the RFID tag **206***f* having RFID signal **214***f* is measured with a strongest RSSI value by antenna **208***f* that is positioned closest with the position of RFID tag **206***f*. Lower power RFID signal **214***k* may also be received by the antenna **208***f*.

The processing unit **210** may be configured to be significantly less dependent on (i) variability of RFID tags **206** and (ii) distance from antennas **208** to tags **206**. Additionally, the processing unit **210** may drive an RF signal at a constant power, and may not need to specifically set the RF signal within a window for each position of the set of positions **200***b*, such as an example provided in FIG. **2**F and described in further detail hereinbelow. In one embodiment, the constant power may be a maximum power of the RF signal. By transmitting the RF signal at a certain power level (e.g., above a threshold power level) or full power, variability of measurement of RSSI of RFID signals may be reduced through a processing process, as further described herein. As understood in the art, a range of alternative configurations may be utilized for aligning the antennas **208** with the tags **206**.

With regard to FIGS. **2**E and **2**F, graphs inclusive of illustrative RF signals transmitted in RF power level ranges are shown. Specifically, FIG. **2**E shows a conventional RF signal **211** (i.e., output signal to an RFID tag that produces RFID signals **215***a* and **215***b*), RF signal **213** that causes RFID tags to produce RFID signal **215***c* that would cause a read error due to the signal strength being too low, and RF signal **209** that results in the RFID tags producing RFID signals **215***d*, **215***e*, and **215***f*.

FIG. **2**F represents signals that may result from an illustrative scenario using a configuration of a dispenser. The RF power level ranges that provide an indication as to whether an RF receiver will not be able to read, only read one, or read multiple RFID signals may include (i) a read error range **236**, (ii) a no cross-talk range **238**, and (iii) a cross-talk range **240**. More specifically, the read error range **236** may be a range in which the RF power level is below a read error threshold **242** that may cause read errors from RFID tags due to receiving RFID signals with insufficient power. The no cross-talk range **238** may be a range in which the RF power level provides for no read errors due to a read RF signal being below a power level that creates cross-talk from RFID tags **206** in adjacent positions and above the read error range **238**. The no cross-talk range **238** extends above the read error threshold **242** and below a cross-talk minimum threshold **244**. The cross-talk range **240** may include RF signals **209** above the cross-talk minimum threshold **244** and below a max RF power level **246**. RF signal **209** intentionally causes RFID signals **215***d*, **215***e*, and **215***f* with power levels in the cross-talk range **240** that result in cross-talk from RFID tags **206** of adjacent positions measured by at least one antenna **208**.

One of skill in the art will understand that current practices target the no cross-talk range **238** between the read error threshold **242** and the cross-talk minimum threshold **244** for outputting RF signal **211** to avoid errors in assigning positions of RFID tags (and corresponding containers and products) caused by cross-talk. As a result, an RSSI value **215***a* adjacent to antenna 1 may be below a transceiver read error threshold **248** and not read while RSSI value **215***b* is returned by an RFID tag in a position corresponding to antenna 1. Additionally, an example of an RF signal with RF power in the read error range **236** is shown with an RFID signal **215***c* with a returned RSSI value below the transceiver read error threshold **248**, which results in a read error.

As a result of using the new algorithm described in FIG. **5**, cross-talk from different RFID tags has no, or limited, problems with previous algorithms used to identify locations of RFID tags. As shown, the RF signal **209** (FIG. **2**D) and RF signals **250***a*-**250***c* (collectively **250**) have power levels above the cross-talk minimum threshold **244**. The RF signal **209** may be transmitted at any power level in the cross-talk range **240**. Even if at least one RFID signal, such as RFID signal **215***d*, has an RSSI value below the transceiver read error threshold **248**, RF signal **209** having an RF power level in the cross-talk range **240** will likely result in cross-talk reads from RFID tags, for example, as shown by RFID signals **215***e* and **215***f* of FIG. **2**E and RFID signals **252***a*-**252***c* (collectively **252**), RFID signals **254***a*-**254***c* (collectively **254**), and RFID signals **256***a*-**256***b* (collectively **256**) of FIG. **2**F. However, as presented in FIGS. **2**D and **5**, and described below, cross-talk errors may be avoided using the sorting module **238** and the assigning module **230** in a sorting algorithm that utilizes RSSI values as a basis.

In operation, for example, at each antenna, such as antennas 1, 2, and 3 of FIG. **2**F, the processing unit **210** may inventory each of the RFID tags **206** that returns an RFID signal based on an RSSI value. An example of hypothetical data including columns for each antenna (e.g. ANTENNA 1) and entries for tag numbers (e.g. Tag 2) and RSSI values (e.g. (47)) read at the antenna in the same column, is shown in TABLE 1:

TABLE 1

ANTENNA 1	ANTENNA 2	ANTENNA 3
Tag 1 (83)	Tag 2 (96)	Tag 2 (81)
Tag 2 (47)	Tag 1 (72)	Tag 3 (78)
	Tag 3 (42)	Tag 1 (43)

Data from the RFID tags **206** may be read and written into a list by listing module **226**. An example of the list is shown in LIST 1:

LIST 1 MASTER LIST
Tag 1 (83)
Tag 2 (47)
Tag 2 (96)
Tag 1 (72)
Tag 3 (42)
Tag 2 (81)
Tag 3 (78)
Tag 1 (43)

Each entry in the list may include, but is not limited to, a unique product identifier corresponding with the product contained in the position, an RSSI value, a unique RFID tag identifier, and a position identifier indicating the position at which the RSSI value was gathered. After the set of positions **200***b* has been inventoried, the sorting module **238** may sort the list by RSSI values, for example, by placing highest RSSI values first. An example of a sorted LIST 1 is shown in LIST 2:

LIST 2 MASTER LIST
Tag 2 (96)
Tag 1 (83)
Tag 2 (81)
Tag 3 (78)
Tag 1 (72)
Tag 2 (47)
Tag 1 (43)
Tag 3 (42)

Beginning with a highest RSSI value, the assigning module **230** may assign the corresponding unique RFID tag identifier to the corresponding position identifier. An example of an assigned position is shown in TABLE 2:

TABLE 2

POSITION 1	POSITION 2	POSITION 3
	Tag 2 (96)	

Additional instances of the unique RFID tag identifier may be removed from the list, by the list remove module **232**, to avoid cross-measurement assignments from occurring. An example of a list including removed instances of the unique RFID tag identifier is shown in LIST 3:

LIST 3 MASTER LIST
Tag 2 (96) = P2
Tag 1 (83)
~~Tag 2 (81)~~
Tag 3 (78)
Tag 1 (72)
~~Tag 2 (47)~~
Tag 1 (43)
Tag 3 (42)

A new highest RSSI value may be identified in the list, and the process of assigning corresponding unique RFID tag identifiers to corresponding position identifiers may be followed until all unique RFID tag identifiers have been either assigned to positions or removed. Additionally, an embodiment of the process is described in further detail hereinbelow with regard to FIG. **5**. An example of a recurring process of the assigning module **230** and list remove module **232** on LIST 3 until completion is sequentially shown in TABLES 3-4 and LISTS 4-5:

TABLE 3

POSITION 1	POSITION 2	POSITION 3
Tag 1 (83)	Tag 2 (96)	

LIST 4 MASTER LIST
Tag 2 (96) = P2
Tag 1 (83) = P1
~~Tag 2 (81)~~
Tag 3 (78)
~~Tag 1 (72)~~
~~Tag 2 (47)~~
~~Tag 1 (43)~~
Tag 3 (42)

TABLE 4

POSITION 1	POSITION 2	POSITION 3
Tag 1 (83)	Tag 2 (96)	Tag 3 (78)

LIST 5 MASTER LIST
Tag 2 (96) = P2
Tag 1 (83) = P1
~~Tag 2 (81)~~
Tag 3 (78) = P3
~~Tag 1 (72)~~
~~Tag 2 (47)~~
~~Tag 1 (43)~~
~~Tag 3 (42)~~

With regard to FIGS. **3**A and **3**B, an illustration of an illustrative vending machine **300** that vends or dispenses consumer products, in this case packaged beverages, inclusive of a set of positions **302** is shown. The set of positions **302** is shown in more detail in FIG. **3**B. The set of positions **302** may include positions **304***a* and **304***n* (collectively **304**) that are used to store and release products for vending to consumers. The positions **304** may alternatively set up as vertical columns. The positions **304** may contain consumer products that include RFID tags **306***a*-**306***n* (collectively **306**) that are affixed to or integrated with the consumer products. As the consumer products are installed, removed, or purchased, sensors **308***a*-**308***n* (collectively **308**) may sense installation, storage, and/or passage of the RFID tags **306** on the products. The sensors **308** are shown to be mounted on the bottom of the positions **304**, but could be mounted elsewhere so long as the alternative positions provide for a high-degree of sensing reliability. An inventory may be established by a processing unit, such as the processing unit **210** of FIG. **2**C, and be updated in response to the sensors **308** sensing movement and/or storage of the products with the RFID tags **306**. The process of identifying positions **304** of the RFID tags **306** may be the same or similar to the process referred to hereinabove with reference to FIGS. **2**A-**2**C. A variety of other functions may additionally be performed.

With regard to FIGS. **4**A and **4**B, an illustration of an illustrative cooler **400** that contains consumer products inclusive of a set of positions **402***a* and **402***b* is shown. The set of positions **402***a* and **402***b* may operate substantially as one set of positions or, alternatively, may be treated, by a processing unit, as two separate sets of positions. The set of positions **402***b* and **402***c* may include individual positions **404***a*-**404***n* (collectively **404**) configured to store consumer products **405***a*-**405***n* (collectively **405**) with RFID tags **406***a*-**406***b* (collectively **406**) that are affixed or integrated with the products. Sensors **408***a*-**408***n* (collectively **408**) may be used to sense the RFID tags **406** associated with the consumer products **405**, and a processing unit may be used to collect and process data read from the RFID tags **406**.

With regard to the set of positions referred to hereinabove relating to FIGS. **2**A-**2**C, **3**A-**3**B, and **4**A-**4**B, the processing unit **210** (or a processing unit operating in any of the other dispenser, vending machine, or cooler) may be configured to communicate with an electronic device, such as the user interface or mobile device of an operator, in response to an incorrect consumer product being placed into a position designated for a different consumer product. In one embodiment, an error message may be communicated to the electronic device to notify the operator that a product or ingredient is positioned incorrectly. In another embodiment, the error message may be communicated to a separate user interface (e.g., mobile device). One of ordinary skill in the art will appreciate that there are many ways to communicate an error message to the operator, including lights or other visual indicators, audible indicator, or otherwise. A user and/or operator may store a particular unique product identifier that is allowable in each unique position identifier. The processing unit **210** may determine if a particular unique product identifier that has been placed in a position is allowable according to the stored particular unique product identifiers assigned to that unique position identifier by the operator.

Additionally, RFID tags may include data representative of at least one of ingredient type, expiration date of the consumer products, manufacturing plant information, status (e.g., temperature) of the consumer product, and a consumer product quantity gauge (e.g., fluid ounces remaining, number of beverage pours remaining, etc.). One of ordinary skill in the art will appreciate that further diagnostic data may be included in RFID signals transmitted from the RFID tags to the processing unit for diagnostic purposes. In one embodiment, the RFID tags may be writable and may receive updated consumer product quantities to replace the consumer product quantity gauge. The updated consumer product quantity may be delivered by an external counter in electrical communication with at least one of the processing unit **210** and the RFID tags. Additionally, the processing unit may communicate to an electronic device for an operator to view diagnostic data, such as, but not limited to, that inventory levels, notifications (e.g., a consumer product is experiencing a malfunction during dispensing), alerts (e.g., a consumer product has been placed in an incorrect position), or otherwise. One of ordinary skill in the art will further appreciate that additional data may be communicated through RFID signals to the processing unit and that the processing unit may communicate any amount of that data to a user and/or operator.

With regard to FIG. **5**, a flow diagram of an illustrative process **500** executable by a machine that identifies positions of RFID tags is shown. The process **500** may be configured to identify positions in which RFID tags are positioned and installed in the machine to provide consumer products to consumers are located. The process **500** may start at step **502**, where a processor may be programmed to cause a transceiver (or the transceiver may operate independently) to generate and output an RF signal. The RF signal may be generated at a certain power level. In one embodiment, the power level may be a maximum level of the transceiver, thereby simplifying the process and preventing or minimizing false readings. The RF signal may be output to antennas in serial or in parallel at each position of a set of positions at which (i) the consumer products are positioned or (ii) the containers are positioned depending on the machine (e.g., dispenser, vending, cooler, etc.).

The RF signal may cause an RFID tag on a container or consumer product to return a signal inclusive of an RSSI level. The RSSI level may be measured, and the processor may read the RFID signal produced by the RFID tag along with the RSSI level at step **504**. In one embodiment, reading the RFID signals produced by the RFID tags in response to being energized by the RF signal may include reading data within the RFID signal. The RFID signal of different tags may include data that includes a unique product identifier and a unique RFID tag identifier.

The processor may record each of the RFID signals into a list with each entry in the list corresponding to a separate RFID signal entry at step **506**. In one embodiment, recording entries into the list may include recording entries inclusive of data corresponding to the RFID tag. The entries may include a corresponding unique RFID tag identifier, a corresponding position identifier, and a corresponding product identifier, a corresponding measured RSSI value. In one embodiment, the list may be sorted by RSSI value.

After determining that the list includes RFID tags that are not assigned to a correct position at step **508**, the processor may identify a highest RSSI value in the list at step **510**. The processor may then assign the corresponding RFID tag identifier to a position based on the corresponding position identifier at step **512**. At step **514**, the processor may remove from the list additional entries including the corresponding RFID tag identifier. Returning to step **508**, the processor may again determine if remaining RFID tags in the list are unassigned. In a condition that RFID tags remain unassigned, the processor may repeat the identifying, assigning, and removing steps **510**, **512**, and **514**, respectively, until all RFID tags are assigned to a position. In a condition that the processor determines that no RFID tags remain unassigned, the process **500** may end at step **516**.

In one embodiment, a set of positions may contain at least two consumer products and corresponding RFID tags in each position. In such a case, the processor is to be configured to support such a fulfillment desire by an operator.

One embodiment of the machine in accordance with the principles described herein may include a multiplexer for routing/reading RF signals to/from antennas.

The foregoing method descriptions and the process flow diagrams are provided merely as illustrative examples and are not intended to require or imply that the steps of the various embodiments must be performed in the order presented. As will be appreciated by one of skill in the art, the steps in the foregoing embodiments may be performed in any order. Words such as "then," "next," etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Although process flow diagrams may describe the operations as a sequential process, many of the operations may be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination may correspond to a return of the function to the calling function or the main function.

The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed here may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

Embodiments implemented in computer software may be implemented in software, firmware, middleware, microcode, hardware description languages, or any combination thereof. A code segment or machine-executable instructions may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a class, or any combination of instructions, data structures, or program statements. A code segment may be coupled to and/or in communication with another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

The actual software code or specialized control hardware used to implement these systems and methods is not limiting of the invention. Thus, the operation and behavior of the systems and methods were described without reference to the specific software code being understood that software and control hardware can be designed to implement the systems and methods based on the description here.

When implemented in software, the functions may be stored as one or more instructions or code on a non-transitory computer-readable or processor-readable storage medium. The steps of a method or algorithm disclosed here may be embodied in a processor-executable software module which may reside on a computer-readable or processor-readable storage medium. A non-transitory computer-readable or processor-readable media includes both computer storage media and tangible storage media that facilitate transfer of a computer program from one place to another. A non-transitory processor-readable storage media may be any available media that may be accessed by a computer. By way of example, and not limitation, such non-transitory processor-readable media may comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other tangible storage medium that may be used to store desired program code in the form of instructions or data structures and that may be accessed by a computer or processor. Disk and disc, as used here, include compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Combinations of the above should also be included within the scope of computer-readable media. Additionally, the operations of a method or algorithm may reside as one or any combination or set of codes and/or instructions on a non-transitory processor-readable medium and/or computer-readable medium, which may be incorporated into a computer program product.

The previous description is of a preferred embodiment for implementing the invention, and the scope of the invention should not necessarily be limited by this description. The scope of the present invention is instead defined by the following claims.

The invention claimed is:

1. A method for identifying positions in which of radiofrequency identification (RFID) tags affixed to consumer products or containers in which ingredients used to form consumer products by a machine that provides consumer products to consumers are located, said method comprising:

generating a radiofrequency (RF) signal at a certain power level;

outputting the RF signal to each position of a set of positions at which the consumer products or containers are positioned;

reading RFID signals produced by the RFID tags in response to being energized by the RF signal, the RFID signals of different tags including (i) a unique product identifier and (ii) a unique RFID tag identifier, the RFID signals having a signal strength that enables measurement of received signal strength indicator (RSSI) values;

recording, into a list, entries for each read RFID signal, the entries including (i) a corresponding unique RFID tag identifier, (ii) a corresponding position identifier, and (iii) a corresponding measured RSSI value; and

determining correct positions of each RFID tag by:

identifying a highest RSSI value in the list;

assigning the corresponding RFID tag identifier to a position based on the corresponding position identifier;

removing, from the list, additional entries including the corresponding RFID tag identifier; and

repeating identifying, assigning, and removing until each of the RFID tags are assigned to a position.

2. The method according to claim **1**, further comprising sorting the list by measured RSSI value.

3. The method according to claim **1**, wherein outputting the RF signal to each position includes outputting the RF signal to each position located inside the machine.

4. The method according to claim **3**, further comprising:

storing unique product identifiers allowable to be placed in respective positions; and

determining whether the unique product identifier corresponding with the RFID tag identifier assigned to the position is the unique product identifier allowable in the position.

5. The method according to claim **4**, wherein, if the unique product identifier corresponding with the RFID tag is determined to not match the unique product identifier allowable in the position, communicating an error message to an operator.

6. The method according to claim **1**, wherein generating the RF signal at the certain power level includes generating the RF signal at a maximum power level.

7. The method according to claim **1**, wherein reading the RFID signals includes reading the RFID signals including diagnostic data of the consumer product.

8. The method according to claim **7**, further comprising communicating a message to an operator representative of the diagnostic data.

9. The method according to claim **1**, wherein reading the RFID signal further includes reading the RFID signal further including at least one of ingredient type, expiration date of the consumer product, manufacturing plant information, status of consumer product, and a consumer product quantity gage.

10. The method according to claim **9**, further comprising writing to the RFID tag.

11. The method according to claim **10**, wherein the writing to the RFID tag includes updating, by a counter configured to be external to the RFID tag, the consumer product quantity gage.

12. A machine for providing consumer products, said machine comprising:

a set of positions configured to contain consumer products or containers in which ingredients used to form consumer products, the consumer products or containers including radiofrequency identification (RFID) tags;

a set of antennas, at least one antenna disposed at each position, and configured to output and receive RF signals, the RF signals at a power level above a cross-talk minimum threshold;

a transceiver in electrical communication with the antennas, and configured to generate the RF signals; and

a processor in communication with said transceiver, and programmed to:

receive RFID signals from the RFID tags at the set of positions;

identify locations of the RFID tags to determine that corresponding consumer products or containers of ingredients are in correct positions;

read RFID signals produced by the RFID tags in response to being energized by the RF signal, the RFID signals of different tags including (i) a unique product identifier and (ii) a unique RFID tag identifier, the RFID signals having a signal strength that enables measurement of received signal strength indicator (RSSI) values; and

record, into a list, entries for each read RFID signal, the entries including (i) a corresponding unique RFID tag identifier, (ii) a corresponding position identifier, and (iii) a corresponding measured RSSI value;

determine correct positions of each RFID tag by being programmed to:

identify a highest RSSI value in the list;

assign the corresponding RFID tag identifier to a position based on the corresponding position identifier;

remove, from the list, additional entries including the corresponding RFID tag identifier; and

repeat identifying, assigning, and removing until each of the RFID tags are assigned to a position.

13. The machine according to claim **12**, wherein the machine is one of a beverage dispenser, a cooler, and a vending machine.

14. The machine according to claim **12**, wherein said processor is further programmed to sort the list by measured RSSI value.

15. The machine according to claim **12**, wherein the consumer products are beverages or the ingredients are used to formulate and produce beverages by the machine.

16. The machine according to claim **12**, wherein said processor is further programmed to prevent operation of the machine in response to determining that a consumer product or container is placed in an incorrect position as designated by an operator based on reading the RFID signals.

17. The machine according to claim 12, further comprising a user interface; and wherein said processor is further programmed to communicate messages for display on a user interface for an operator in response to reading the RFID signals.

18. The machine according to claim 12, wherein a first position is configured to contain a first consumer product and corresponding RFID tag and a second position is configured to contain a second consumer product and corresponding RFID tag.

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